SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, Makoto Saotome, a citizen of Japan residing at Kawasaki, Japan and Takayuki Hatanaka, a citizen of Japan residing at Atsugi, Japan have invented certain new and useful improvements in

ELECTRONIC DEVICE

Of which the following is a specification:-

TITLE OF THE INVENTION
ELECTRONIC DEVICE

BACKGROUND OF THE INVENTION

5   1. Field of the Invention

The present invention relates to an
electronic device, more specifically, to a
peripheral device such as a storage device connected
to a computer, a communication device, or a memory
10   card reader, capable of a self-test by using a
simple testing device.

2. Description of the Related Art

Recently, along with the great progress in
semiconductor integrated circuits, the increasingly
15   lowered prices thereof, and the increased speed of
communication by the Internet, personal computers
(PCs) have become widely used, and the peripheral
devices connected to PCs such as storage devices,
communication devices and so on are in a larger and
20   larger variety.

Various kinds of interfaces are used to
connect the peripheral devices with PCs. In
particular, the Universal Serial Bus (USB) and the
IEEE 1394 are being used nearly as standards for
25   such kind of interfaces, the former being mainly
used recently as an interface for data transmission,
and the latter being used for moving pictures or
other kinds of image data. Furthermore, a
drastically increasing number of the peripheral
30   devices are being shipped which are equipped with
USB or IEEE 1394 as standard configurations.

FIG. 1 is a schematic view of a usual
configuration of a peripheral device equipped with a
USB interface (hereinafter, referred to as "USB
35   device"). The USB device 100 is connected to a PC
101 through a USB cable 102 that is on the basis of
the USB interface.

A USB device controller 105 receives commands from applications executed in a CPU 103 of the PC 101 through a USB host controller 104 and a USB cable 102, and thereby the CPU 106 of the USB

5   device 100 operates in response to the commands. These commands are transferred in packets, which packet is the minimum transfer unit, or in combinations of packets. A packet consists of a synchronization pattern, a packet ID, and commands.

10   As the modulation scheme, NRZI (Non return to Zero Inverted) is used.

      FIG. 2 shows a configuration of a USB cable. In the case of the full speed (transfer speed: 12Mbps) of the USB 1.1 standard, and the case

15   of the USB 2.0 standard (transfer speed: 480Mbps), the USB cable 102 is comprised of signal lines D+, D-, a ground line GND, a +5V-power-line Vb, and a shield line 107 covering all the above lines. Here, the two signal lines D+ and D- form a pair and

20   transfer commands or data by differential methods. The +5V-power-line Vb supplies electric power to the USB device 100 from the host side, such as PC 101. The shield line 107 shields the USB cable from static electricity and electromagnetic waves, and is

25   connected to the ground line GND on the side of the PC 101, and is floated from the ground line GND on the side of the USB device 100.

      Turning to the problem to be solved by the present invention, although the USB interface has

30   advanced functions such as Plug & Play, in order to control the USB device 100, commands have to be created from the packets described above, and this makes necessary the USB host controller 104 and the PC 101 for controlling the USB host controller 104.

35   Accordingly, PCs are indispensable when checking USB devices or at service stations for maintenance, and this makes the cost for checking higher, and thus

increases manufacturing cost.

SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention to solve one or more problems of the related art.

A more specific object of the present invention is to provide an electronic device capable of device testing by using inexpensive testing devices.

To attain the above object, according to a first aspect of the present invention, there is provided an electronic device configured to be connected by a serial bus including a signal line and a shield line, comprising a signal receiving unit configured to receive signals from the shield line, and an identification unit connected to the signal receiving unit and configured to identify the received signals, wherein a self-test is performed based on results of the identification.

According to the first aspect of the present invention, the electronic device receives signals from the shield line, identifies the signals, and carries out a self-test. Since the shield line is not used for transferring signals in data transmission, simple signals can be used as the commands of self-tests, and simple circuits can be used for identifying the received signals. As a result, device testing can be done by using inexpensive testing devices, and the electronic device of the above invention can be tested by just adding the inexpensive testing circuits.

Preferably, the signals from the shield line include one of direct-current voltage signals, tone signals, and digital signals.

To attain the above object, according to a second aspect of the present invention, there is

provided an electronic device configured to be
connected by a serial bus including a signal line,
comprising a signal receiving unit configured to
receive signals off a standard for the serial bus

5   from the signal line, and an identification unit
connected to the signal receiving unit and
configured to identify the received signals, wherein
a self-test is performed based on results of the
identification.

10   According to the second aspect of the
present invention, signals off the serial bus
standard are used for self-tests, and are received
by the electronic device via the signal line.
Because the signals off the serial bus standard are

15   simple, simple circuits can be used to identify the
received signals. As a result, device testing can be
done by using inexpensive testing devices, and the
electronic device of the above invention can be
tested by just adding inexpensive circuits.

20   Preferably, the signals off the serial bus
standard include one of signals having voltages
exceeding the serial bus standard, signals different
in transmission speed from the serial bus standard,
and signals different in protocol from the serial

25   bus standard.

           These and other objects, features, and
advantages of the present invention will become more
apparent from the following detailed description of
the preferred embodiments given with reference to

30   the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS
           Fig. 1 is a schematic view of a usual
configuration of a USB device;

35   Fig. 2 is a view showing a configuration
of a USB cable;
           Fig. 3 is a block diagram of a

configuration of an electronic device according to a first embodiment of the present invention;

Fig. 4 is a block diagram of a configuration of a testing system for self-tests of the USB device according to the first embodiment of the present invention;

Fig. 5 is a flow chart for explaining operation of the testing system;

Fig. 6 is a block diagram of a first example of a configuration of the testing system for self-tests according to the first embodiment of the present invention, wherein a USB device is connected with a testing device;

Fig. 7 is a view showing the relation between inputs of a switch SW and test modes;

Fig. 8 is a block diagram of a second example of a configuration of a testing system according to the first embodiment of the present invention, wherein a USB device is connected with a testing device;

Fig. 9 is a block diagram of a third example of a configuration of a testing system according to the first embodiment of the present invention, wherein a USB device is connected with a testing device;

Fig. 10 is a block diagram of a configuration of an electronic device according to a second embodiment of the present invention;

Fig. 11 is a block diagram of a configuration of a testing system for self-tests of the USB device according to the second embodiment of the present invention;

Fig. 12 is a block diagram of a fourth example of a configuration of a testing system for self-tests according to the second embodiment of the present invention, wherein a USB device is connected with a testing device; and

Fig. 13 is a block diagram of a fifth example of a configuration of a testing system for self-tests according to the second embodiment of the present invention, wherein a USB device is connected

5 with a testing device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Below, preferred embodiments of the present invention will be explained with reference

10 to the accompanying drawings.

First Embodiment

FIG. 3 is a block diagram of a configuration of a USB device related to the first

15 embodiment of the electronic device according to the present invention.

Referring to FIG. 3, the USB device 10 is comprised of a main circuit 11 for receiving command signals from a host and executing data transmission

20 or other various basic functions of the USB device 10, and a testing circuit 12 for receiving test command signals from the outside, identifying the test command signals and conducting self-tests.

The main circuit 11 provides various basic

25 functions of the USB device 10, and includes a data receiver 13 connected with a data line D+, a data line D-, a 5V-power line Vb, and a ground line GND of a USB interface, a main controller 16 comprising a controller for controlling communications with a

30 PC or other hosts via the data lines D+ and D- in accordance with the USB interface standard and a CPU for operating the main circuit 11 in response to the received commands, a display 18 for showing the operation conditions of the USB device 10, and an

35 I/F unit 19 for inputting data from and outputting data to a memory card 20 connected with the USB device 10. Note that the connector 25 of the data

receiver 13, which is connected with outside
terminals such as the data lines D+, D-, also serves
as the later-shown connector of the receiver 22 of
the testing circuit 12.

5   The testing circuit 12 includes a receiver
22 connected with a shield 21 of the USB interface,
an identification unit 23 (indicated by "ID unit" in
FIG. 3) for identifying commands based on test
command signals received by the receiver 22, and a
10   testing controller 24 that determines a test mode
based on a signal for specifying a type of the test
received from the identification unit 23 and directs
the main circuit 11 to perform a test.

          The receiver 22 is mounted with a USB
15   connector 25, for example, a USB receptacle or a USB
plug. The shield 21 of the connector 25 (hereinafter,
referred to as "shield line") is connected with the
receiver 22. Further, its ground line GND is
connected with the ground line GND of the receiver
20   22.

          According to the USB standard, the USB
shield line 21 is floated, not being connected with
the ground line GND on the side of the USB device,
that is, the USB shield line 21 is idle according to
25   the USB standard. In the present invention, the USB
shield line 21 is used for receiving test command
signals.

          The identification unit 23 converts the
signals from the receiver 22 to digital ones
30   according to the signal types by using a comparator,
an AD converter, a PLL (Phase Locked Loop) circuit,
or a UART (Universal Asynchronous Receiver
Transmitter) circuit.

          The testing controller 24 retains the
35   digital data converted in the identification unit 23
in the registers 26, and a CPU 27 of the testing
controller 24 carries out one kind, or kinds of

tests. Here, the so-called "test" includes, for example, checking data in an inner memory of a CPU of the main controller 16, checking operation of the I/F unit 19, and checking operation of the memory
5   card 20 connected to the USB device 10.

FIG. 4 is a block diagram showing a configuration of a testing system for self-tests of the USB device 10.

Referring to FIG. 4, the testing system 30
10   includes the aforesaid USB device 10, a testing device 32 sending test command signals, and a USB cable 31 connecting the USB device 10 and the testing device 32.

The testing device 32 is comprised of a
15   power supplier 33 for supplying electric power to the USB device 10, an input unit 34 comprising a plurality of push switches, and a signal generator 35 for generating and transmitting test command signals according to the selected switch.

20   The power supplier 33, for example, is implemented as a switching power supplier, supplying a +5V power voltage to the USB device 10 through the USB cable, and electric power to drive the signal generator 35.

25   The input unit 34, for example, is provided with a toggle switch, or push switches, or other means facilitating selection of a test mode. After selecting a switch, the signal generator 35 generates signals corresponding to the position of
30   the selected switch.

The signal generator 35, for example, is able to generate any one of DC voltage signals, tone signals, and digital signals. For example, it is comprised of a variable voltage applying circuit, or
35   a sinusoidal signal generating circuit, or a digital signal generating circuit, or others. The output terminal of the signal generating circuit 35 is

connected with the shield line 21, and the test command signal generated here is transmitted by the shield line 21 to the receiver 22 of the USB device 10 as shown in FIG. 3.

5   Next, operation of the above testing system is explained with reference to FIG. 5.

FIG. 5 is a flow chart explaining operation of the testing system shown in FIG. 4.

In step S100, the USB device 10 is 10   connected to the testing device 32.

In step S102, a power voltage of +5V is supplied to the USB device 10.

In step S104, a test mode is input at the input unit 34 of the testing device 32.

15   In step S106, a test command signal is generated in the signal generator 35 in response to the inputted test mode.

In step S108, the test command signal is transmitted through the shield line 21 of the USB 20   cable 31, and is received by the receiver 22 of the USB device 10.

In step S110, the test command signal is converted into parallel digital data in the identification unit 23, and is retained in the 25   register 26 of the testing controller 24.

In step S112, for example, the CPU 27 of the testing controller 24 determines the test mode according to the data stored in the register 26. For example, if the data in the register 26 are "01" as 30   shown in step S114, the CPU 27 of the testing controller 24 carries out a test selected from test 1 through test 3 to test programs stored in a ROM.

In step S118, results of test 1 are shown in the display 18, and then the test is finished.

35   If it is desired to continue the test, the test mode should be input again to the input unit 34 of the testing device 32, as done in step S104.

According to the present embodiment, the USB device 10 receives the test command signals through the shield line 21, and the test command signals are simple signals such as DC voltage

5 signals, tone signals, or digital signals, so simple and inexpensive circuits can be used to configure the identification unit 23. Further, the testing device 32 does not need to include a PC, thus can also be configured by using inexpensive devices.

10 Accordingly, device testing can be done by using inexpensive testing devices, and the electronic device of the present embodiment can be tested by just adding inexpensive circuits.

Next, examples of the present embodiment

15 are presented especially for detailed explanations of the test command signals, the identification unit 23, and the testing device 32 connected with the USB device 10.

20 Example 1

This example relates to a USB device wherein the test command signals are DC voltage signals each having a different level.

FIG. 6 is a block diagram showing a

25 configuration of a testing system for self-tests, wherein a USB device is connected with a testing device. Note that the same numeral references are assigned to the same parts as those already described, and explanations thereof are omitted.

30 Referring to FIG. 6, the testing system 47 comprises a USB device 40, a testing device 45, and a USB cable 31 connecting them. An AD converter 41 is used as the identification unit 23 of the USB device 40, and a variable voltage circuit 46 is used

35 as the signal generator 35 of the testing device 45.

The variable voltage circuit 46, for example, is comprised of a circuit for dividing the

power voltage by resistors. If one of the three
switches SW 1 through 3 is switched ON, a voltage
corresponding to a specific test mode is selected.
For example, if there are three test modes test 1,
5 test 2, and test 3, DC voltages of 1V, 2V, and 3V
are assigned to these three modes, respectively.

The selected DC voltage signal, which
functions as the test command signal, is transmitted
through the shield line 21 of the USB cable 31,
10 received in the receiver 22 of the USB device 40,
and is input to the AD converter 41. According to
the voltage of the test command signal, the AD
converter 41 outputs two bits parallel data to the
register 26 of the testing controller 24. The data
15 are latched in the register 26, and the CPU 27 of
the testing controller 24 performs testing in
response to the data.

FIG. 7 shows the relation between the
inputs of the switches SW 1 through 3 and the test
20 mode. Specifically, shown in FIG. 7 is the relation
between the inputs of the switches SW 1 through 3,
the test command signals of the variable voltage
circuit 51, and the register 26 and the test modes.
As shown in FIG. 7, when all of the switches SW 1
25 through 3 are set OFF, testing is not performed, and
when one of the switches SW 1 through 3 is set ON,
test command signals corresponding to the switch are
generated, and a test in response to the test
command signals is executed.
30 According to the above example, since DC
voltage signals transmitted through the shield line
21 are used as the test command signals, a simple
testing circuit 12 can be configured by using the AD
converter 41, and the testing device 45 can also be
35 configured by using a simple circuit such as the
variable voltage circuit 46. Accordingly, device
testing can be done by using inexpensive testing

devices, and the electronic device of the present embodiment can be tested by just adding inexpensive circuits.

5   Example 2

This example relates to a USB device wherein the test command signal is a sinusoidal signal having a plurality of frequencies.

FIG. 8 is a block diagram showing a
10   configuration of a testing system for self-tests, wherein a USB device is connected with a testing device.

Referring to FIG. 8, the testing system 57 comprises a USB device 50, a testing device 55, and
15   a USB cable 31 connecting them. A PLL circuit 51 and an AD converter 52 are used as the identification unit 23 of the USB device 50, and a sinusoidal signal generator 56 is used as the signal generator 33 of the testing device 55 to generate test command
20   signals.

The sinusoidal signal generator 56, for example, includes a Wien bridge oscillation circuit. For example, if one of the three switches SW provided in the testing device 55 is switched ON, a
25   frequency corresponding to a specific test mode is selected. For example, if there are three test modes test 1, test 2, and test 3, frequencies of 1 kHz, 2 kHz, and 3 kHz are assigned to them, respectively.

The selected sinusoidal test command
30   signal is transmitted through the shield line 21 of the USB cable 31, received in the receiver 22 of the USB device 50, and is input to the PLL circuit 51.

The PLL circuit 51 outputs a DC voltage proportional to the difference between the
35   oscillation frequency of a voltage control oscillation circuit constituting the PLL circuit 51, and the oscillation frequency of the test command

signal. The maximum of the output is converted to digital data by the AD converter 52 and two bit parallel data are output to the register 26 of the testing controller 24. The data are latched in the
5 register 26, and the CPU 27 of the testing controller 24 performs testing in response to the data. Concerning the relation between ON/OFF state of the switches and the test mode, it is the same as that shown in FIG. 7 except that the test command
10 signals are different.

According to the above example, since sinusoidal signals transmitted through the shield line 21 are used as the test command signals, a simple testing circuit 12 can be configured by using
15 the PLL circuit 51 and the AD converter 52, and the testing device 55 can also be configured by using a simple circuit such as the sinusoidal oscillation circuit 56. Accordingly, device testing can be done by using inexpensive testing devices, and the
20 electronic device of the present embodiment can be tested by just adding inexpensive circuits.

Note that in the identification unit 23, a frequency-voltage converting (F/V conversion) circuit can also be utilized instead of the PLL
25 circuit 51.

Example 3

This example relates to a USB device wherein the test command signal is a digital signal
30 having a plurality of frequencies.

FIG. 9 is a block diagram showing a configuration of a testing system for self-tests, wherein a USB device is connected with a testing device.
35 Referring to FIG. 9, the testing system 67 comprises a USB device 60, a testing device 65, and a USB cable 31 connecting them. A UART receiver 61

is used as the identification unit 23 of the USB
device 60, and a UART transmitter 66 is used as the
signal generator 33 of the testing device 65 to
generate test command signals. This example is the
same as the second example except for usage of a
serial digital data signal as the test command
signal, usage of the UART transmitter 66, and usage
of the UART receiver 61 as the identification unit
23.

The UART transmitter 66, for example, uses
a circuit able to vary the serial data generated
when a switch SW is selected. Such a circuit may be
constituted by a TTL logic circuit, or a
microcomputer. If the transmission speed of the test
command signals is 1 kbps, the serial data signals
corresponding to three test modes are set to be
eight-bit data "00000000", "11111111", and
"01010101", respectively.

The UART receiver 61 converts the input
serial data that functions as the test command
signal to parallel data, and the test command signal
is output to the register 26 of the testing
controller 24.

According to the above example, since
serial data signals transmitted through the shield
line 21 are used as the test command signals, a
simple testing circuit 12 can be constituted by
using the UART receiver 61, and the testing device
65 can also be configured by using a simple circuit
such as the UART transmitter 66. Accordingly, device
testing can be done by using inexpensive testing
devices, and the electronic device of the present
embodiment can be tested by just adding inexpensive
circuits.

Second Embodiment
FIG. 3 is a block diagram of a

configuration of a USB device related to the second
embodiment of the electronic device according to the
present invention. In the following embodiment and
examples, the same numeral references are assigned
5   to the same parts as those already described, and
the explanations thereof are omitted.

Referring to FIG. 10, the USB device 70 is
comprised of an I/O unit 71 for inputting data from
and outputting data to a host computer connected
10 with the USB device 70 by a USB interface, a main
circuit 72 for receiving command signals from the
host and executing data transmission or other
various basic functions of the USB device 70, and a
testing circuit 73 for receiving test command
15 signals from the outside, identifying the test
command signals, and conducting self-tests.

The I/O unit 71 is comprised of a USB
connector 25 having terminals for connection with
the data lines D+, D-, the ground line GND, the +5V-
20 power-line Vb, and the shield line 21, a receiver
for converting differential signals received via the
data lines D and D- to TTL signals, and outputting
them to the main circuit 72 and the testing circuit
73, and a receiving and transmitting circuit for
25 converting the signals from the main circuit 72 to
differential signals and transmitting them to the
host via the data lines D+ and D-. In accordance
with the USB standard, either the data line D+ or
the data line D- is pulled up to 3.0 V ~ 3.6 V by a
30 1.5kΩ resistor, so this portion is compensated for
when converting the received differential signals.

The same as the main circuit 11 in the
first embodiment, the main circuit 72 provides
various basic functions of the USB device 70. The
35 main circuit 72 is connected to an external
electronic device 75 through an I/F device of the
USB device 70.

The testing circuit 73 includes an identification unit 74 for identifying test commands signals received by the I/O unit 71, and a testing controller 24 that determines a test mode based on a signal for specifying a type of the test received from the identification unit 74 and instructs the main circuit 72 to perform a test.

The identification unit 74 includes circuits configured in accordance with the test command signals generated by the signal generator 76 of the testing device 75 described later. As shown later, signals off the USB standard are used as the test command signals, and depending on the types of the test command signals, the identification unit 74 may include a pulse detection circuit, a transmission speed comparison circuit, and so on. Using these circuits, the test command signals are converted to parallel digital data, and are output to the testing controller 24.

The testing controller 24 is the same as that of the first embodiment.

FIG. 11 is a block diagram showing a configuration of a testing system for self-tests of the USB device 70.

Referring to FIG. 11, the testing system 77 includes the aforesaid USB device 70, and a testing device 75 connected with the USB device 70 by a USB cable 31 and sending test command signals to the USB device 70.

The signal generator 76 generates test command signals according to the selection of the input unit 34, and converts them to differential signals, and outputs signals of inverted phases to the data lines D+ and D-. Here, as the test command signal, signals off the USB standard are generated. For example, such kind of signals may include signals having voltages exceeding the serial bus

standard, signals different in transmission speed from the serial bus standard, and signals different in protocol from the serial bus standard. In the USB standard, transmission speeds are specified to be 12

5 Mbps, 15 Mbps, and 480Mbps for the low speed and full speed of the USB 1.1, and the high speed of the USB 2.0, respectively. Further, as the minimum unit of command signals and data signals, the format of a packet is defined in the USB standard. Further, as

10 the modulation scheme, NRZI (Non Return to Zero Inverted) is used. In the present embodiment, signals deviating from the above specifications are used as the test command signals. For example, use can be made of signals including repeated data "1"

15 in NRZ (Non Return to Zero) having a transmission speed of a few kbps to 10 kbps, or signals of a few bits. Such kind of test command signals can be easily generated by a multivibrator circuit, or by a TTL IC of one-shot or flip-flop.

20   Operation of the testing system 77 is the same as that explained in FIG. 5.

        According to the present embodiment, the USB device 70 receives the test command signals through the data lines D+ and D-, and the test

25 command signals are simple digital signals, so simple and inexpensive circuits can be used to configure the identification unit 74. Further, the testing device 75 does not need to include a PC, and can also be configured by using inexpensive devices

30 having simple signal generators 76. Accordingly, device testing can be done by using inexpensive testing devices, and the electronic device of the present embodiment can be tested by just adding inexpensive circuits.

35   Examples of the present embodiment are shown below.

Example 4

This example relates to a USB device wherein the test command signal includes a pulsed signal of a few bits.

5   FIG. 12 is a block diagram showing a configuration of a testing system for self-tests, wherein a USB device is connected with a testing device.

Referring to FIG. 12, the testing system
10   87 comprises a USB device 80, a testing device 85, and a USB cable 31 connecting them. A pulse detection circuit 81 is used as the identification unit 74 of the USB device 80, and a variable pulse generator 86 is used as the signal generating
15   circuit of the testing device 85.

The variable pulse generator 86 uses a circuit able to vary the pulse number generated when a switch SW is selected. Such a circuit may be constituted by a TTL logic circuit, or a simple
20   microcomputer.

Assuming the transmission speed of the test command signals is 1 kbps, a value deviating from the aforesaid USB standard, the pulse numbers corresponding to two test modes are set to be two
25   bits and three bits, respectively.

The test command signals are transmitted by the data lines D+ and D- of the USB cable 31, and are converted to TTL signals in the I/O unit 71 of the USB device 80, and are input to the pulse
30   detection circuit 81 of the identification unit 74.

The pulse detection circuit 81 counts pulses only at predetermined pulse intervals, and transmits the resultant parallel digital signals to the register 26 of the testing controller 24. Such a
35   circuit may be constituted by, for example, a TTL logic circuit.

According to the above example, since

simple pulse signals out of the USB standard are used as the test command signals, a simple testing circuit 73 can be constituted, and the testing device 85 can also be configured by using a simple

5 circuit such as the variable pulse generator 86. Accordingly, device testing can be done by using inexpensive testing devices, and the electronic device of the present embodiment can be tested by just adding inexpensive circuits.

10

Example 5

This example relates to a USB device wherein the test command signal includes a digital signal having a plurality of frequencies.

15 FIG. 13 is a block diagram showing a configuration of a testing system for self-tests, wherein a USB device is connected with a testing device.

Referring to FIG. 13, the testing system

20 97 comprises a USB device 90 and a testing device 95, and a USB cable 31 connecting them. The identification unit 74 of the USB device 90 is comprised of a transmission speed comparison circuit 91 and a reference pulse generator 92. In addition,

25 a digital signal generator 96 is used as the signal generating circuit of the testing device 95.

The digital signal generator 96 uses a circuit able to vary the transmission speed of pulses generated when a switch SW is selected. Such

30 a circuit may be constituted by a multivibrator circuit. The transmission speeds of the test command signals corresponding to two test modes are set to be 10 kbps, and 20 kbps, respectively, which deviate from the aforesaid USB standard, and the NRZ is used

35 as the modulation scheme.

The test command signals are transmitted by the data lines D+ and D- of the USB cable 31, and

are converted to TTL signals in the I/O unit 71 of
the USB device 90, and are input to the transmission
speed comparison circuit 91 of the identification
unit 74.

5   The transmission speed comparison circuit
91 is connected to the reference pulse generator 92.
For example, in the reference pulse generator 92,
reference signals at 10 kbps and 20 kbps and
modulated by NRZ are generated, and in the

10 transmission speed comparison circuit 91, the test
command signals are compared with the reference
signals. When they are coincident, the test command
signals are written to the register 26 according to
the transmission speed of the test command signal.

15 The transmission speed comparison circuit 91, for
example, can be constituted by PLL circuits and TTL
logic circuits.

     According to the above example, since
digital signals having transmission speeds off the

20 USB standard are used as the test command signals, a
simple testing circuit 73 can be constituted, and
the testing device 95 can also be configured by
using a simple circuit such as a signal generator.
Accordingly, device testing can be done by using

25 inexpensive testing devices, and the electronic
device of the present embodiment can be tested by
just adding inexpensive circuits.

     While the invention has been described
with reference to specific embodiments chosen for

30 purpose of illustration, it should be apparent that
the invention is not limited to these embodiments,
but numerous modifications could be made thereto by
those skilled in the art without departing from the
basic concept and scope of the invention.

35   For example, the testing controller 24 and
the main controller 16 may use the same CPU, and
thereby the cost can be lowered further. In addition,

the USB device and the testing device may be connected directly by USB connectors, for example, by the USB plug provided in the USB device, and the receptacle provided in the testing device.

5 Furthermore, in the above descriptions, examples of USB devices using USB interfaces are used for explanations, but the present invention is not limited to the USB interface, for example, it is also applicable to USB devices using the IEEE 1394

10 interface.

Summarizing the effect of the invention, according to the present invention, it is possible to provide an electronic device capable of device testing by using inexpensive testing devices.

15 This patent application is based on Japanese priority patent application No. 2002-190558 filed on June 28, 2002, the entire contents of which are hereby incorporated by reference.